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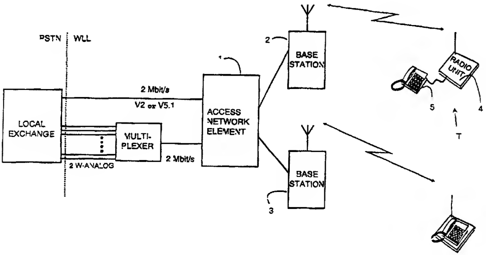

(57) Abstract

The invention relates to a wireless local loop system comprising base stations and an access network node which connects the cordless terminal equipments (T) to the exchange of the fixed network. The air interface between the cordless terminal equipment and the base station (2, 3) is mainly in accordance with the GSM mobile system, whereupon at least one time slot (TN0) of a frame having a carrier that is the carrier (c0) of signalling is a time slot of a control channel (FCCH, SCH, BCCH, CCCH), in which time slot the base station transmits, with constant power, control information intended for the cordless terminal equipments. According to the invention, the co-channel interference can be decreased in such a way that the other time slots (TN1, ..., TN7) of said frame are reserved as traffic channel time slots only as the need arises, and in traffic channel use the transmit power of the signalling carrier (c0) is adjusted in a manner required by the mobile system. Discontinuous transmission DTX can also be used.

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Radio system for cordless subscriber line interface

The invention relates to a wireless local loop system comprising base stations and an access network node which connects the cordless terminal equipments to the exchange of the fixed network. The system especially comprises an air interface between the cordless terminal equipment and the base station, the interface being mainly in accordance with a TDMA mobile system wherein at least one time slot of a frame with signalling frequency (c0) is a control channel time slot in which a base station transmits, with standard power, control information intended for cordless terminal equipments.

When a telephone network is being built, the installation of the subscriber lines between the exchange and the subscriber equipments is not only considerably expensive but also requires a great deal of time. Usually the network of subscriber lines is formed in such a way that twin cables beginning in several subscriber equipments are supplied to a distribution frame, and cables originating in several crossbar switches are combined in another distribution frame the cable of which is supplied to the exchange. The signalling interface between the exchange and the subscriber lines is standardized, and it is either an interface of two-wire analogous subscriber lines, a multiplexer interface according to Recommendation V2 of the CCITT, or a message-based multiplexer interface according to Recommendation V5.1 of the ETSI. Altering fixed subscriber lines is troublesome, and maintenance costs especially in areas where the subscriber lines are overhead lines can be considerable. A solution to these problems is replacing the fixed lines between the exchange and the subscriber equipments with radio lines.

The solution is known as a wireless local loop (WLL) system.

The principle of the WLL system is shown in Figure 1. A wireless stationary terminal equipment T comprises a radio unit 4 provided with an antenna, and a telephone adapter that connects a standard subscriber equipment 5 to the terminal equipment. The subscriber equipment may be a normal telephone set, a telefax terminal, or a modem. It is attached to the terminal equipment by inserting a standard plug in the adapter connection of the terminal equipment. The user utilizes the subscriber equipment 5 in the same way as in a conventional fixed network, even though the subscriber line connection consists of a radio line between the terminal equipment T and the base station BS 2 or 3. The base station may serve several subscriber equipments. The base station is connected to a special access network node 1, which in turn is connected to a standard exchange. Several base stations may be connected to one access network node 1.

The WLL system may be built by using components of an existing mobile phone system. The mobile system may be for example an analogous NMT system or a digital GSM system. In such a case, the signalling of the WLL system is in accordance with the system concerned, the base stations are standard base stations of this system, and the radio unit of the terminal equipment is similar to the radio unit of the mobile station or the terminal equipment may be a mobile station in a mobile system. An important component in the WLL system is the access network node that connects the subscribers to the standard local exchange. The access network node converts the WLL network signalling, for example NMT or GSM signalling, into signalling suitable for the fixed network (e.g. PSTN), and correspondingly it adapts the

signalling of the fixed network to the WLL network interface.

The network node is connected to the local exchange with an open V2- or V5.1-type multiplexer interface that utilizes a 2 Mbit/s PCM system. If the local exchange only supports the two-wire interface, the network node is connected to the exchange by converting the V2 signalling into an analogous two-wire subscriber loop interface by means of a multiplexer. The signalling between the network node and the base stations connected thereto is the signalling of an adapted mobile network, but it is modified in such a way that the functions, such as cell handover and roaming, typical of the cellular network are prevented. Therefore, the subscriber must remain within the coverage area of the base station assigned to it. The routing of an incoming call and an outgoing call is based on the subscriber database of the network node. The operation of the network node corresponds to the operation of a concentrator: a call is forwarded from a subscriber interface to the exchange, and the analysis of the numbers, calculation and other functions are performed in the exchange.

According to what is described above, a WLL network may be based on a known GSM system. The GSM is a digital cellular system based on time division multiple access. The channels of the system will be described below.

Logic channels are divided into traffic channels TCH that transmit speech and data, and into control channels that forward signalling and synchronization data. Control channels include broadcast channels, common control channels and dedicated channels. Broadcast channels BCH are channels directed from a base station to a mobile station (downlink) and

they include (i) a frequency correction channel FCCH the information of which is used by the mobile station for frequency correction, (ii) a synchronization channel SCH which forwards frame synchronization information and the identification of the base station to the mobile station, and (iii) a broadcast control channel BCCH which forwards general information concerning the base station. Common control channels CCCH include in the downlink direction a paging channel PCH which is used for transmitting paging messages to the mobile stations, in the uplink direction a random access channel RACH that is used by the mobile stations to request a channel from the network, and in the downlink direction an access grant channel AGCH with which the network acknowledges the requests transmitted by the mobile stations. Dedicated channels include a stand alone dedicated control channel SDCCH, and a slow associated control channel SACCH and a fast associated control channel FCCH associated with traffic channels.

Logic channels are mapped to physical channels of the radio path. As is known, a physical channel consists of successive windows that are determined by a time slot and a frequency. A particular physical channel always utilizes the same time slot number in each TDMA frame consisting of eight time slots, but the frequency may change when frequency hopping is used.

51 TDMA frames form a control channel multiframe that is schematically shown in Figure 2. Both the FCCH and the SCH have the same structure: an SCH time slot follows an FCCH time slot at a distance of one frame, and the multiframe has five time slots reserved for each channel. Each channel utilizes the time slot TN0 of the frame. The BCCH utilizes four time slots in the multiframe and the time slots are situated in successive frames. The rest of the 36 time slots (each

in its own TDMA frame) are reserved for the CCCH, i.e. in the case of a frame in the downlink direction, for the PCH and the AGCH, and in the case of a frame in the uplink direction, for the RACH. For practical reasons, both the BCCH and the CCCH also utilize the time slot TN0. The length of repetition of the control channel multiframe is thus 51 durations of a TDMA frame. Frequency hopping is not allowed in the time slot TN0, but the aforementioned channels using this time slot must use the same fixed frequency. According to the specification, the BCCH carrier must be transmitted, however, in all time slots constantly with constant power and at a standard frequency, usually with the highest allowable power. The frequency of the carrier at which the control information is transmitted is denoted with c0. In the time slots where no information is transmitted, a so-called dummy burst is formed by utilizing stuffing bits. The BCCH carrier c0 transmitted continuously with standard power and at a standard frequency is utilized in such a way that a mobile station periodically measures the signal strength of the carrier of the BCCHs in neighbouring cells and it also determines the connection quality by means of the bit error ratio, whereupon the measurement results are utilized in the handover procedure.

In the GSM system, error-correcting coding is utilized on the traffic channel in order to obtain as error-free radio transmission as possible. The coding is two-phase channel coding wherein light block coding is used mainly for error detection and convolutional coding is used for error correction. In convolutional coding, the errors must be randomly distributed in time before the code can be used efficiently. Therefore interleaving in used wherein a channel-coded block is transmitted at least in four time slots, the bits of the

channel-coded block are mixed before transmission so that transmission errors are randomized, and adjacent blocks are interleaved to be transmitted in the same time slot. The interleaving as such is sufficient if the mobile station is moving, but frequency hopping is also used since it improves the random distribution of errors in the case of a slowly moving or stationary mobile station. Another advantage of frequency hopping is that the co-channel interference which is caused by another user in another cell utilizing the same frequency is averaged. The background for the coding and frequency hopping is that the received signal is a sum of Rayleigh-fading signals having different delays, whereupon the variation in signal level and quality is strong. The frequency hopping and the rate of the hopping decrease and at best eliminate the correlation between successive bursts, whereupon the errors are randomized due to interleaving and bit reorganization.

A strong carrier that is continuously transmitted is a problem in some cases, however. It brings about an increase in the interference level of the network, i.e. when a traffic channel carrier in the cell is the same as the BCCH carrier of a nearby cell, it causes interference in the reception. This decreases the network capacity. In low-capacity cells wherein only one transmission and reception frequency, i.e. one TRX, is used on the traffic channel, there must be an additional transmitter/receiver at the base station if frequency hopping is used, this additional transmitter/ receiver transmitting the BCCH carrier during the same time slot in which the actual transmitter/receiver generates the traffic channel frequency. This is necessary since one transmitter/ receiver can be used to synthesize a large number of frequencies but only one frequency at a time.

These interference problems also concern the WLL system described in the beginning when the GSM system is applied as such to WLL use. Especially when the WLL system is applied in sparsely inhabited regions, it is very likely that the base station only utilizes one transmission and reception frequency (one TRX frequency) and that the coverage area of the base station is vast. In such a case, in addition to the fact that the transmit power of the BCCH carrier is high, which increases the co-channel interference in the telephone traffic and decreases the network capacity, an additional transmitter/receiver must be placed at the base station for the purpose of frequency hopping for forming the BCCH carrier c0. The frequency hopping is also necessary, or at least desirable, with one TRX, since its absence causes deterioration in the efficiency of convolutional coding because in the case of stationary or slowly moving mobile stations mere interleaving is not sufficient to produce a random error distribution. The network capacity also decreases due to the fact that when the interference of the same channel is not averaged by frequency diversity, greater frequency diversity must be used, i.e. less channels are obtained with the same frequency allocation.

The object of the present invention is a wireless local loop system, based on the TDMA system and especially the GSM system, in which system the BCCH carrier c0 does not cause the kind of problems that are described above and that would result from the use of a standard BCCH carrier of the GSM system.

The objective is achieved in the manner disclosed in claim 1.

In the WLL radio system according to the invention, the BCCH carrier c0 is transmitted with standard power only in the time slot wherein control

information is transmitted, and in the other time slots the carrier is not transmitted at all or the other time slots are used, as the need arises, for traffic channels during which the power of the BCCH carrier is adjusted normally. These other time slots thus contain no transmission if there is no traffic. If there is traffic, power control, frequency hopping and discontinuous transmission (DTX) are used. DTX means that transmission is discontinued during speech pauses. Less interference, good frequency diversity and better code performance are thus obtained at the reception.

In the following, the invention will be described in greater detail with reference to the accompanying drawings, in which

Figure 1 shows the principle of the WLL system

Figure 2 shows a multiframe of a control channel, and

Figure 3 is an example of the BCCH carrier arrangement according to the invention.

In WLL applications, a subscriber may move within his home cell, but intercell handover is prevented. Therefore it is not necessary to measure the strength of the BCCH carrier of the nearby stations. In the WLL system according to the invention, the BCCH carrier therefore does not have to be continuously transmitted in all the time slots of the frame using this carrier frequency c0, but it is transmitted with maximum power only in the time slots which form the BCCH and the CCCH. This time slot is time slot TN0 of RF channel c0 in Figure 3. The other time slots TN1,...,TN7 of the frame utilizing the carrier frequency c0 can be used as traffic channel time slots, if required. In these time slots, power control is used normally for the frequency c0. Since the carrier is not transmitted with

maximum power or it is not transmitted at all, the co-channel interference is considerably decreased.

When only one TRX, in Figure 3 frequency c0, is allocated to a cell, frequency hopping between the BCCH frequency c0 and the frequency c1 to be synthesized can still be performed by utilizing the same transmitter/receiver. A possible channel utilizing frequency hopping is described with arrows combining the time slots of these RF channels. The channel is formed of the fourth time slot of the frame. One frequency synthesizer is sufficient, because when a burst is transmitted in the fourth time slot of the frequency C1, the transmission of a BCCH carrier in the simultaneous fourth time slot of the frequency c0 is not necessary at all.

When several TRX frequencies are allocated to a cell, the frequency hopping can be performed between these frequencies, and the BCCH carrier c0 can be switched off in time slots TN1,...,TN7. These time slots can naturally be utilized for traffic channels, whereupon normal power control is performed on the carriers and these time slots can also be used for frequency hopping.

When the arrangement according to the invention is used for the BCCH carrier, certain features of the standard GSM system can be omitted: handover algorithm is not necessary and therefore the base station does not have to transmit a list of neighbouring cells, and a subscriber equipment does not have to monitor the BCCH carrier of nearby cells and to perform measurements related thereto or report the measurement results to the network. If frequency hopping is not performed, the BCCH carrier does not have to be transmitted continuously, but only in time slot TN0.

A further advantage of the invention is that especially in the case of low-capacity cells, frequency reuse is more efficient in the network since a strong carrier is not constantly on. Furthermore, the power consumption of the terminal equipment decreases since there is no need to monitor the BCCH carrier of the neighbouring base stations. This is important since in most cases the terminal equipments are battery-driven.

It must be understood that the above description and the figures related thereto are only intended to illustrate the present invention. Different variations of the invention will be evident for those skilled in the art without deviating from the scope and spirit of the invention disclosed in the appended claims.

Claims

1. A wireless local loop system comprising base stations and an access network node which connects the cordless terminal equipments (T) to the exchange of the fixed network, the air interface between the cordless terminal equipment and the base station (2, 3) being mainly in accordance with a TDMA mobile system in which at least one time slot (e.g. TN0) of a frame having a carrier that is the basic carrier (c0) of signalling is a time slot of a control channel (FCCH, SCH, BCCH, CCCH), in which time slot the base station transmits, with constant power, control information intended for the cordless terminal equipments, characterized in that in the other time slots (e.g. TN1,...,TN7) of said frame, the burst is transmitted only in the time slots (e.g. TN2) required.

2. A radio system according to claim 1, characterized in that the time slot (e.g. TN2) in which the burst is transmitted is a traffic channel time slot, and that the transmit power of the signalling carrier (c0) acting as the burst carrier is adjusted in a manner required by the mobile system.

3. A radio system according to claim 1, characterized in that when the frame time slot is other than a traffic channel time slot or a control channel time slot, the signalling carrier (c0) is not transmitted at all.

4. A radio system according to claim 1, characterized in that frequency hopping is allowed in the traffic channel time slot of the frame.

5. A radio system according to claim 2 or 4, characterized in that discontinuous transmission (DTX) is used on the traffic channel.

6. A radio system according to claim 1 or 4, c h a r a c t e r i z e d in that in the system one TRX frequency, which is the signalling carrier frequency (c0), and at least one other frequency (c1) are allocated to the base station, and that on the traffic channel the frequency hopping occurs between the TRX frequency and some other frequency (c1) whereupon both frequencies are formed with the same frequency synthesizer.

7. A radio system according to claim 1, c h a r a c t e r i z e d in that the cordless terminal equipment (T) only listens to information transmitted on the control channel by the base station assigned to the terminal equipment.

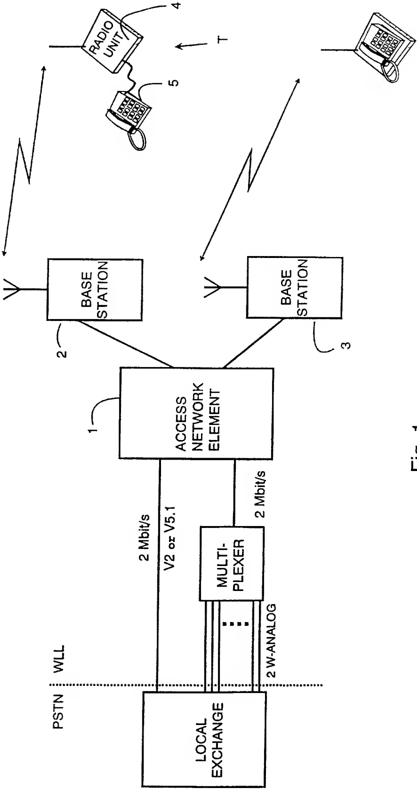
RADIO UNIT
4
T
5
BASE STATION
BASE STATION
2
3
1
ACCESS NETWORK ELEMENT
2 Mbit/s
V2 or V5.1
2 Mbit/s
MULTI-PLEXER
2 W-ANALOG
WLL
PSTN
LOCAL EXCHANGE

Fig. 1

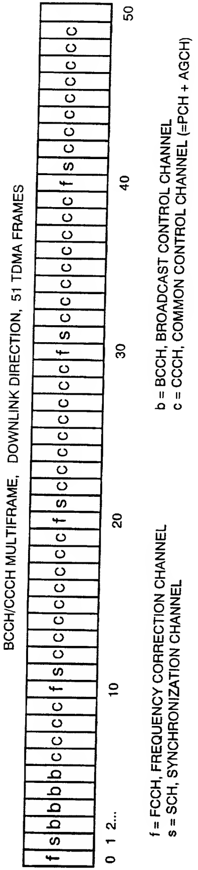
BCCH/CCCH MULTIFRAME, DOWNLINK DIRECTION, 51 TDMA FRAMES
f s b b b b c c c c f s c c c c c c c c f s c c c c c c c c f s c c c c c c c c f s c c c c c c c c
0 1 2...
10
20
30
40
50
f = FCCH, FREQUENCY CORRECTION CHANNEL
s = SCH, SYNCHRONIZATION CHANNEL
b = BCCH, BROADCAST CONTROL CHANNEL
c = CCCH, COMMON CONTROL CHANNEL (=PCH + AGCH)

Fig. 2

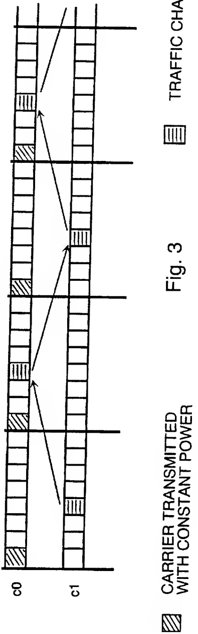
c0
c1
CARRIER TRANSMITTED WITH CONSTANT POWER
TRAFFIC CHANNEL

Fig. 3